THE 10,000 YEAR GUARANTEE: HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL AT YUCCA MOUNTAIN, NEVADA

*Aletheia Gooden**

I. INTRODUCTION

Chernobyl rested on the Pripiat River in northcentral Ukraine, unknown to the rest of the world. Unfortunately, its anonymity did not last forever. On April 26, 1986 at 1:23 A.M., the number four reactor at the V.I. Lenin Nuclear Power Plant exploded and released thirty to forty times the radioactivity of the atomic bombs dropped on Hiroshima and Nagasaki.[1] The volcano-like explosion at Chernobyl killed thirty-one individuals instantly and significantly exposed 600,000 others to radiation. Over 100,000 Ukrainians, Russians, and Belorussians had to abandon entire cities and settlements within the 18.6 mile extreme contamination zone.[2] The average risk of developing a general cancer increased by 0.15% to 0.6% for those exposed to the radiation. Those living near the reactor at the time of the melt-down experienced genetic damage and around 760 children living in the supposed "safety zone" developed thyroid cancer. The average risk of developing thyroid cancer increased by 0.9% to 5.0% for those exposed.

Along with the human health and safety impacts of a nuclear accident, there are environmental and financial impacts as well.[3] Billions of rubles (31.27 Rubles = 1 USD) were spent and continue to be spent on soil decontamination. The radiation caused mutations and death in animals. A ban on milk, meat, fruits and vegetables was placed in 1986 and 1987 in Eastern Europe as a result.

Nuclear contamination burned large amounts of vegetation throughout countries in Europe. The explosion had the greatest impact on forests because of the high filtering characteristics of trees.[4] A "red forest"

---

* Aletheia Gooden is a third year law student at UC Davis, School of Law. She received a B.S. in Environmental Policy Analysis and Planning from UC Davis. She is interested in the study and practice of environmental law.

1 NUCLEAR ENERGY AGENCY, CHERNOBYL TEN YEARS ON RADIOLOGICAL AND HEALTH IMPACT, *at* http://www.nea.fr/html/rp/chernobyl/chernobyl.pdf; Peter Bleickardt, *Chernobyl'*, *at* http://www.ibiblio.org/expo/soviet.exhibit/chernobyl.html (Jan. 10, 2002).

2 *Id.*

3 *Id.*

4 NUCLEAR ENERGY AGENCY, *supra* note 1, at 9.

was created near the Chernobyl site, where the radiation was so high it killed all the trees, and the trees had to be handled and destroyed as radioactive waste.[5]

The nuclear accident at Chernobyl impacted the world.[6] The explosion blew radioactive particles into the sky to form a plume that traveled by wind to other countries. Once rain hit the plume, the radionuclides reached the ground, and contamination spread.[7]

The nuclear disasters at Chernobyl and Three Mile Island (Pennsylvania) stopped the development of nuclear power plants.[8] Though no new reactors have been built since 1979 in the United States, the threat of a nuclear explosion is not the only problem associated with nuclear power.[9] Nuclear reactors produce high-level radioactive waste in the form of spent fuel rods. Permanent disposal of the spent fuel creates uncertainty and substantial risk to human health and safety, and the environment. This paper analyzes the radioactive waste disposal problem and its potential affects on human health and safety. It addresses the laws affecting high-level radioactive waste disposal. The proposed geologic repository at Yucca Mountain, Nevada and the problems, logistics, status, and legal battles against locating the nation's nuclear waste dump at Yucca Mountain are discussed. Lastly, this paper presents possible solutions to the nuclear disposal dilemma.

II. The Radioactive Waste Disposal Problem

This section addresses current and future radioactive waste production and its potential effects on human health and safety.

A. Amounts and Sources

Following World War II federal nuclear weapons testing increased along with the development of commercial nuclear power plants.[10] Inevitably, these activities began to produce large amounts of high-level radioactive waste. High-level radioactive waste is defined as radioactive solids, liquids, or gases that initially produce large amounts of ionizing

---

5 *Id.*

6 Bleickardt, *supra* note 1.

7 *Id.*

8 *Id.*

9 Christopher Flavin & Nicholas Lenssen, Nuclear Power Nears Peak as the 20th Anniversary of Three Mile Island Approaches, the Nuclear Industry Faces Slow Slide to Oblivion, Worldwatch Institute, *at* http://www.worldwatch.org/alerts/990304.html (Mar. 5, 1999.)

10 John Gross, *Nuclear Native America: Nuclear Waste and Liability on the Skull Valley Goshute Reservation*, 7 B.U. J. Sci. & Tech. L. 140, 143 (2001).

radiation.[11] Examples include nuclear fission waste products such as spent fuel rods and assemblies, coolant fluids, and gases.[12] Currently, 109 operating nuclear power plant reactors and nine shutdown reactors exist in the United States at seventy-three different reactor plant sites.[13] These facilities supply twenty percent of our nation's electricity and in doing so produce 2000 metric tons annually of high-level radioactive waste.[14]

This high-level radioactive waste is in the form of spent nuclear fuel that is created by the fission process at nuclear reactor sites.[15] The fuel that runs nuclear power plants is made up of small uranium and plutonium pellets. The pellets are placed inside long metal fuel rods that are grouped together to form fuel assemblies. The fuel assemblies are placed inside the reactor. During the fission process, uranium-235 gains a neutron and becomes an unstable uranium-236, which splits apart, discharging two fission fragments, two or three neutrons, and gamma rays.[16] The energy released from the fission process is in the form of kinetic energy. The kinetic energy is used to boil water into steam, which drives a turbine-generator to produce commercial electricity.

The pieces left over after the atom is split are radioactive. Gradually, the uranium and plutonium are burned up and the trapped fission pieces decrease the chain reaction efficiency. As a result, every eighteen months the old fuel assemblies are removed and new fuel is added. The used fuel is removed from the reactor and stored in steel lined, concrete vaults filled with water near the nuclear facilities. If the storage pools fill up, the spent fuel is stacked in dry cask storage near the reactor site. The average nuclear reactor produces thirty tons of spent fuel annually.[17]

Today, there is over 42,000 metric tons of used fuel sitting in water cooling ponds or dry cask storage at nuclear plant sites.[18] Plant operators are allowed to use dry cask storage if the cask design is approved by the Nuclear Regulatory Commission (NRC).[19] The NRC developed dry cask storage systems, or Independent Spent Fuel Storage Installations (ISFSI's) to expand interim storage of spent fuel both on-site near reac-

---

11 THOMAS J. SCHOENBAUM & RONALD H. ROSENBERG, ENVIRONMENTAL POLICY LAW 784 (3d ed. 1996).

12 *Id.*

13 Jason Hardin, *Tipping the Scales: Why Congress and the President Should Create a Federal Interim Storage Facility for High-Level Radioactive Waste*, 19 J. LAND RESOURCES & ENVTL. L. 293, 298 (1999).

14 Amy Sypula, *Beyond Yucca Mountain: Split Liability Drives Action for Interim Nuclear Waste Storage*, 6 U. CHI. L. SCH. ROUNDTABLE 251, 253 (1999).

15 *Id.*

16 GILBERT M. MASTERS, INTRODUCTION TO ENVIRONMENTAL ENGINEERING AND SCIENCE 71 (Prentice Hall 1998) (1991).

17 Hardin, *supra* note 13, at 295.

18 THOMAS J. SCHOENBAUM & RONALD H. ROSENBERG & HOLLY DOREMUS, ENVIRONMENTAL POLICY LAW 36 (4th ed. 2001).

19 42 U.S.C. § 10153 (West 1995).

tors and off-site away from nuclear facilities.[20] Dry cask storage is initially licensed for twenty years and can be licensed for up to 100 years with review and approval by NRC.[21] Spent fuel will continue to be produced annually at a rate of 2000 metric tons through the year 2010.[22] If a significant number of reactor licenses are not extended beyond their forty-year licensing period,[23] spent fuel production will gradually decline and end in the 2030s. By that time, there will be approximately 85,000 metric tons of spent nuclear fuel.[24]

In addition to spent fuel generated from the commercial nuclear power industry, defense and research activities by the federal government produce spent fuel and high-level nuclear waste. Approximately 8.3 million cubic yards of federal weapons production waste is in temporary storage at the DOE's Savannah River plant in South Carolina and the DOE's Hanford Reservation in Washington.[25] Spent nuclear fuel from nuclear-powered naval vessels and naval reactor prototypes is also transported, tested, and stored at the National Engineering Laboratory in Idaho and in New York.[26] Much of this waste is contaminating the environment because it is stored in leaky containers.[27] On sixteen different occasions between 1987 and 1991, toxic gases were released from the storage facilities, and injured workers.[28]

B. Potential Health and Environmental Effects

The production and accumulation of spent fuel creates environmental and human health concerns.[29] The uranium involved in the fission process must be mined and extracted from the earth. The mining of uranium ore produces radioactive and chemical waste and causes ecological damage.[30] Mine tailings contain toxic metals such as arsenic, cadmium,

---

20 10 C.F.R. § 72.42 (2002).

21 10 C.F.R. § 72.3 (2002).

22 NUCLEAR WASTE TECHNICAL REVIEW BOARD, DISPOSAL AND STORAGE OF SPENT NUCLEAR FUEL—FINDING THE RIGHT BALANCE (United States) (Mar. 1996).

23 42 U.S.C. § 2133(c) (West 1994).

24 NUCLEAR WASTE TECHNICAL REVIEW BOARD, *supra* note 22.

25 SCHOENBAUM & ROSENBERG, *supra* note 11; Michael B. Gerrard, *Fear and Loathing in the Siting of Hazardous and Radioactive Waste Facilities: A Comprehensive Approach to a Misperceived Crisis*, 68 TUL. L. REV. 1047, 1075 (1994).

26 Hardin, *supra* note 13, at 295; Gerrard, *supra* note 25, at 1075.

27 SCHOENBAUM & ROSENBERG, *supra* note 11, at 794.

28 Gerrard, *supra* note 25, at 1075.

29 This paper addresses the problems associated with spent radioactive fuel but it is important to note that spent fuel is not the only waste byproduct and waste disposal problem associated with the production of nuclear energy.

30 MARK D. JACKSON, RADIOACTIVITY: WHAT YOU DON'T SEE CAN KILL/HEAL YOU, *at* http://www.science.fall.edu/chemistry/xpl/radioact.prn.pdf (last visited May 20, 2002).

mercury, and the radionuclides involved in the decay of uranium-238.[31] Toxic metals are hazardous to human health and the environment. Additionally, only 0.72% of naturally occurring uranium is the desired isotope uranium-235.[32] For this reason, an enrichment facility is needed to increase the naturally occurring concentration of uranium by two to three percent so it can be used in the reactors.

Spent fuel is dangerous to human health and the environment because it contains radioactive material with very long half-lives.[33] The pieces left over from the fission process contain cesium-137, which concentrates in muscles and has a half-life of thirty years; strontium-90, which concentrates in bone and has a half-life of twenty-eight years; and iodine-131, which concentrates in the thyroid gland and has a half-life of 8.1 days.[34] Uranium-238, another element present in spent fuel, has a half-life of 4.5 billion years. There are many other long-lived radionuclides produced by fuel reactors that make spent fuel radioactive for tens of thousands of years.

Radioactive elements pose a threat to living organisms because they are unstable and undergo spontaneous changes within their nucleus, which emit alpha, beta, or gamma radiation.[35] Spent fuel emits alpha, beta, and gamma radiation. Alpha particles are large and easy to stop. Human skin sufficiently blocks external alpha radiation from entering the body. However, if alpha particles are taken internally through inhalation or ingestion, they can severely impact the body. Alpha particles cause ionization in surrounding atoms. Alpha's positive charge attracts electrons in its path, raising their energy levels and possibly removing them completely from their nuclei. Ionization harms living organisms by breaking down molecules into ions, destroying the molecule and creating reactive fragments.[36]

Beta particles move faster and are lighter than alpha particles. Beta particles are electrons that are emitted from an unstable nucleus as a result of the spontaneous transformation of a neutron into a proton plus

---

31 MASTERS, *supra* note 16, at 72.

32 *Id.*

33 *Id.*

34 A half-life is the amount of time it takes for one-half of the quantity of the element to decay either to a stable form or to another element in the decay chain. (*Id.*) For example, the following is the decay life of plutonium-239, a radioactive waste present in spent fuel. Plutonium has a half-life of 24,390 years, at which time it decays and forms uranium-235. Uranium-235's half-life is 704,800 years, at which time it decays and forms thorium-231. Thorium-231's half-life is twenty-six hours, at which time it decays and forms radium-227. The decay chain continues to include nine more elements before the original radionuclide becomes lead-207 and is stable.

35 MASTERS, *supra* note 16, at 68.

36 JACKSON, *supra* note 30.

an electron.[37] Beta particles can travel several centimeters into human tissue.[38] However, they can be stopped by glass or a sheet of aluminum one-cm thick.

Gamma rays are the third type of radiation emitted by spent fuel. Gamma rays have short wavelengths and thus are highly energetic and cause biologically damaging ionization. Concrete, steel, or several centimeters of lead is most often used to block these rays.[39]

Alpha, beta, and gamma radiation produced by high level radioactive waste are very dangerous to living organisms. For example, an individual standing one yard away from an unprotected, ten year-old fuel assembly, would receive a lethal dose of radiation in under three minutes.[40] Radiation causes surrounding molecules to become unstable which results in molecular damage including the breakage of chemical bonds.[41] It takes a long time for an organism to respond to molecular damage caused by radiation. This is why the effects of radiation may remain undetected for many years. Skin cells are most easily burned by radiation; in the same way severe sunburns damage skin layers.[42] Additionally, low-level radiation causes somatic and/or genetic cellular damage.[43] Somatic damage increases the risk of the following cancers: leukemia, bone, thyroid, breast, skin, and lung.[44] Somatic effects also include sterility, cataracts, burns, and a reduction in lifespan. Genetic damage on the other hand, affects future generations by mutating reproductive cells.

III. The Law of Radioactive Waste Disposal

In 1954, with the enactment of the Atomic Energy Act,[45] the government first permitted the private use and ownership of nuclear reactors.[46] The Act made the federal government responsible for the disposal of high-level radioactive waste resulting from commercial nuclear fission.[47] The perception at that time was that spent fuel could be recycled or disposed of safely.[48]

---

37 Masters, *supra* note 16, at 68.

38 *Id.*

39 Radiation and Foreign Research Reactor Spent Fuel, *at* http://www.nsc.org/public/ehc/rad/fsf_ch6.pdf (last visited May 19, 2002).

40 Public Citizen, Get the Facts on Nuclear Waste Transportation, www.nirs.org/roadsrails/road.PDF (last visited May 20, 2002).

41 Masters, *supra* note 16, at 69.

42 Jackson, *supra* note 30.

43 Masters, *supra* note 16, at 69.

44 *Radiation and Foreign Research Reactor Spent Fuel*, *supra* note 39.

45 42 U.S.C. §§ 2011-2259 (West 1994).

46 42 U.S.C. § 2133(a) (West 1994).

47 42 U.S.C. § 2012(c) (West 1994).

48 Lawrence Flint, *Shaping Nuclear Waste Policy at the Juncture of Federal and State Law*, 28 B.C. Envtl. Aff. L. Rev. 163, 166 (2000).

Up until the late 1970s, nuclear fuel was commercially reprocessed and recycled.[49] The current nuclear reactor fission process uses up only a small percentage of the fuel's energy, leaving behind highly radioactive waste, with great energy potential. Reprocessing the spent fuel would reduce the amount of high-level waste but it would also result in the isolation of plutonium.[50] Plutonium creates a potential nuclear weapons proliferation risk. Because of this risk and the threat of terrorism, President Carter suspended the commercial reprocessing of spent nuclear fuel in 1977.[51] The United States currently supports the "Nonproliferation and Export Control Policy" of 1993 which discourages the reprocessing of spent fuel and the commercial trade of plutonium for energy.[52] Unlike in the United States, spent nuclear fuel is reprocessed and recycled in other countries such as the United Kingdom, France, and Japan.[53]

Congress passed the Nuclear Waste Policy Act[54] (NWPA) in 1982 to address the issue of spent fuel storage. Like the Atomic Energy Act, NWPA made the federal government responsible for the permanent disposal of high-level nuclear waste.[55] However, the Act placed primary responsibility for storing spent fuel on the producers of nuclear power.[56]

A. The Nuclear Waste Policy Act (1982) and The Nuclear Waste Policy Amendments Act (1987)

NWPA[57] provides a comprehensive program for the management and disposal of spent radioactive fuel generated by commercial nuclear reactors.[58] The federal government is responsible for the ultimate disposal of the radioactive waste but the nuclear utilities are responsible for the interim storage of the spent fuel before it is received by the federal government.[59] The federal government is instructed under NWPA to dis-

---

[49] *Id.*; Gerrard, *supra* note 25, at 1075 (The only operating commercial reprocessing plant was located in West Valley, New York. The plant reprocessed nuclear waste for six years, before closing in 1972. The plant's closure left behind hundreds of thousands of gallons of highly radioactive liquid waste and a legacy of fires and accidents.).

[50] *Id.* at 167.

[51] *Id.*

[52] THE WHITE HOUSE OFFICE OF THE PRESS SECRETARY, FACT SHEET NONPROLIFERATION AND EXPORT CONTROL POLICY, *at* http://www.fas.org/spp/starwars/offdocs/w930927.htm (Sept. 27, 1993).

[53] UNITED STATES DEPARTMENT OF ENERGY, HISTORY OF THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM, *at* http://www.ymp.gov/timeline/index.htm (last visited May 20, 2002).

[54] 42 U.S.C. §§ 10101-10270 (West 1995).

[55] 42 U.S.C. § 10131(a)(4) (West 1995).

[56] 42 U.S.C. § 10131(a)(5) (West 1995).

[57] 42 U.S.C. §§ 10101-10270 (West 1995).

[58] 42 U.S.C. § 10131(b) (West 1995).

[59] 42 U.S.C. § 10131(a)(4),(5) (West 1995).

pose of spent nuclear fuel and high-level radioactive waste in underground geologic repositories.[60] The idea for a geologic repository originated in 1957 when the National Academy of Sciences determined that the best way to protect human health and safety and the environment would be to bury radioactive waste in rock deep underground.[61] In the 1960s the government studied thick salt deposits as possible repository sites. The government also studied the possibility of using basalt and welded turf and other volcanic rock types for a repository in the 1970s.

The United States Department of Energy (DOE) was authorized under NWPA to find, build, and operate the geologic repositories.[62] NWPA instructed DOE to identify three potential sites for the first underground storage facility and to conduct a site characterization of each of the three sites.[63] In 1983, after ten years of data collection, DOE selected nine locations in six states for potential underground radioactive waste storage facilities.[64] The following are the nine candidate site locations: Vacherie dome, Louisiana (salt dome); Cypress dome, Mississippi (salt dome); Richton dome, Mississippi (salt dome); Yucca Mountain, Nevada (tuff); Deaf Smith County, Texas (bedded salt); Swisher County, Texas (bedded salt); Davis Canyon, Utah (bedded salt); Lavender Canyon, Utah (bedded salt); and Hanford Site, Washington (basalt flows).[65] From the nine proposed sites, the Secretary of Energy (Secretary) was required to pick three to recommend to the President.[66] An environmental assessment needed to accompany each site.[67] In 1984, Draft Environmental Assessments were done for all nine sites.

NWPA requires the Secretary to consult with the Council of Environmental Quality, the Administrator of the Environmental Protection Agency, and the Director of the United States Geological Survey to develop guidelines which "specify factors that qualify or disqualify any site from development as a repository, including . . . hydrology, geophysics, seismic activity, . . . proximity to water supplies, [and] populations."[68] The guidelines should consider the proximity of the repository to sites where high-level radioactive waste and spent nuclear fuel is generated and the transportation and safety issues involved in moving such waste to

---

60 42 U.S.C. § 10131(b)(1) (West 1995).

61 UNITED STATES DEPARTMENT OF ENERGY, *supra* note 53.

62 42 U.S.C. § 10191(2) (West 1995).

63 42 U.S.C. § 10132(b)(1)(B) (West 1995).

64 UNITED STATES DEPARTMENT OF ENERGY, *supra* note 53.

65 *Id.*

66 42 U.S.C. § 10132(b)(1)(B) (West 1995).

67 42 U.S.C. § 10132(b)(1)(D) (West 1995); 42 U.S.C. § 10132(b)(1)(D)(i)-(vi) (West 1995) (environmental assessment requirements).

68 42 U.S.C. § 10132(a) (West 1995).

the repository.[69] In December of 1984, DOE issued general guidelines for the recommendation of the sites.[70] In 1996, the specific citing guidelines were revised with the following generalized guidelines.[71] First, the repository must allow for containment of waste in accordance with the Environmental Protection Agency (EPA) standards and NRC regulations after closure. Second, the repository must abide by EPA's standards established specifically for Yucca Mountain and NRC's regulations during construction, operation, and closure.

The Secretary recommended Yucca Mountain, Nevada; Deaf Smith County, Texas; and Hanford Site, Washington to the President for approval site characterization. The President approved the three sites in 1986.[72] Due to the high costs associated with researching geologic repositories, Congress postponed all work for a second repository and reassessed its need to characterize three potential storage facilities.[73] In 1987 Congress passed the Nuclear Waste Policy Amendments Act, directing DOE to study a repository only at Yucca Mountain, Nevada.[74]

Site characterization is the initial step in determining if a facility is suitable to store the nation's high-level radioactive waste.[75] Site characterization at Yucca Mountain involved studying the geology and hydrology of the site. Scientists observed the depth, thickness, and extent of the host rock at Yucca Mountain and whether it responded to heat or water. They studied the ground water at the site and the amount of water present, where the water comes from, how far the water table is from the surface, and in what direction the water flows. The amount of surface water at Yucca Mountain was also observed. Researchers studied the terrain at the site and the potential for volcanic activity and earthquakes. Scientists also observed the climate in the past at Yucca Mountain and predicted future temperatures in the area and what impact climate could have on a repository. Yucca Mountain was initially picked as a repository because of its arid condition, lack of water, isolated water basin, and low population density near the site. Yucca Mountain's deep water table would allow the repository to be placed 1,000 feet underground and still be 800 feet above the water table.[76]

Site characterization also includes analyzing the social, environmental, and economic impacts a repository has on a location. Social effects

---

69 *Id.*

70 10 C.F.R. § 960 (2002).

71 NUCLEAR WASTE PROJECT OFFICE, UPDATE ON NUCLEAR WASTE PROGRAM DEVELOPMENTS, *at* http://www.state.nv.us/mucwaste/news/upd4-97.htm (Apr. 1997).

72 51 Fed. Reg. 19783 (June 2, 1986); *Nevada v. Herrington*, 827 F.2d 1394, 1397 (9th Cir. 1987).

73 42 U.S.C. § 10172 (West 1995).

74 *Id.*

75 42 U.S.C. § 10133(a) (West 1995).

76 Sypula, *supra* note 14, at 260.

of locating a repository at a site include impacts on: schools, public health, law enforcement, fire protection, medical care, cultural and recreational needs, distribution of public lands to allow for timely expansion of facilities, social services, and transportation.[77] Environmental effects are addressed in the required Environmental Impact Statement[78] discussed below. Economic effects include the impact a repository will have on Nevada's tourism, property values, and economic development and growth.[79]

After site determination is complete the Secretary has two choices. If the Secretary determines the site is unsuitable, he must terminate all site characterization activities and notify Congress, and the Governor and Legislator of the state where the site is located.[80] Additionally, he must reclaim the site and report to Congress within six months on recommendation for further action, including the need for new legislative authority.[81] If upon completing site characterization, the Secretary determines the site is suitable, he may recommend the site to the President for development as a geologic repository.[82] With the recommendation of the site, the Secretary must provide to the public and submit to the President a thorough statement explaining his decision.[83] The statement must include, among other things, a final Environmental Impact Statement[84] pursuant to the National Environmental Policy Act.[85]

The Secretary must notify the Governor and Legislature of the State where the repository is located at least thirty days prior to making a recommendation to the President.[86] If the President accepts the Secretary's recommendation, NWPA requires the President to submit a recommendation of the site to Congress.[87] The site designation is effective sixty days after the President's proposal unless a Notice of Disapproval is submitted by the Governor and legislature of the State where the site is located, or by the authoritative body of a Native American Tribe on whose reservation the site is located.[88] If a Disapproval Notice is submitted, the site is disapproved unless within the first ninety days of a continuing ses-

---

77 42 U.S.C. § 10174(b) (West 1995).

78 42 U.S.C. § 10134(a)(1)(D) (West 1995).

79 Texas Electric Service Co. v. Nelon, 546 S.W.2d 864, 869 (Tex. Ct. App. 1977); Gerrard, *supra* note 25, 1078; SCHOENBAUM & ROSENBERG, *supra* note 11, at 788.

80 42 U.S.C. § 10133(c)(3) (West 1995).

81 42 U.S.C. § 10133(c)(3)(F) (West 1995).

82 42 U.S.C. § 10134(a)(1) (West 1995).

83 42 U.S.C. § 10134(a)(1)(D) (West 1995).

84 *Id.*

85 42 U.S.C. § 4321-4370 (West 1994).

86 42 U.S.C. § 10134(a)(1) (West 1995).

87 42 U.S.C. § 10134(a)(2)(A) (West 1995).

88 42 U.S.C. § 10135(b) (West 1995).

sion of Congress after the submittal, Congress passes a resolution of siting approval.[89]

The Governor and legislature of a State or the authoritative body of a Native American Tribe can only submit a Notice of Disapproval if they did not previously enter into a Benefits Agreement with the Secretary.[90] A Benefits Agreement entitles the State or Native American Tribe where the repository or a Monitored Retrievable Storage (MRS) facility is located to obtain financial payments before and after the spent fuel is received.[91] If Nevada entered into a Benefits Agreement it would receive $10 million before accepting the radioactive waste, $20 million upon receiving the first of the spent fuel, and $20 million annually thereafter until closure of the facility.[92] The downside to entering into a Benefits Agreement is that once entered into, the State or Native American Tribe gives up its right to disapprove the site.[93] Nevada wants to legally challenge the designation of Yucca Mountain as a repository and so did not enter into a Benefits Agreement or receive funding.

If the President recommends a site and its designation becomes effective, NWPA requires DOE to submit an application to NRC for a license permitting construction of the repository.[94] If the application is approved and construction begins, NWPA instructs DOE to apply to NRC for licensing authority to accept waste into the repository and to close the site once the spent fuel and radioactive waste are properly stored inside.[95] Operations at the repository will last for 100 years, during which time the wastes are still retrievable.[96] After this time period, access to the underground storage site will close but above-ground monitoring will continue for 10,000 years. Eventually, the surface facilities at the Yucca Mountain site will be dismantled.[97]

NWPA sets the total amount of high-level radioactive waste allowed to be stored in the repository at 70,000 metric tons.[98] The geologic repository was initially intended only to hold commercial spent fuel. However, this changed in 1985 when President Reagan determined that

---

89 42 U.S.C. § 10135(c) (West 1995).

90 42 U.S.C. § 10173(a)(1) (West 1995).

91 42 U.S.C. § 10173 (West 1995); Scott R. Helton, *The Legal Problems of Spent Nuclear Fuel Disposal*, 23 ENERGY L. J. 179, 184 (2002) (MRS was proposed as an offsite interim storage facility. It was designed to serve as a holding location where spent nuclear fuel could be monitored until a permanent disposal solution was found. With the designation of Yucca Mountain as the radioactive waste repository, the MRS system is placed on hold.)

92 42 U.S.C. § 10173(a)(1) (West 1995).

93 *Id.*

94 42 U.S.C. § 10134(b) (West 1995).

95 10 C.F.R. § 63.51 (2002).

96 UNITED STATES DEPARTMENT OF ENERGY, *supra* note 53.

97 10 C.F.R. § 63.52(a) (2002); 10 C.F.R. § 960.4 (2002) (post-closure guidelines).

98 42 U.S.C. § 10134(d) (West 1995).

defense waste should be stored with commercial spent fuel in a single repository.

To pay for the geologic repository NWPA created a Nuclear Waste Fund (NWF).[99] Generators of commercial nuclear power were required to pay a one-time fee based on the amount of electricity generated in a nuclear power reactor prior to April 7, 1983, and an ongoing fee of one-tenth of one cent (one mil) for each kilowatt-hour of electricity produced, which they are allowed to pass on to their customers.[100] The Secretary may review the ongoing fee amount annually and adjust it to cover the federal government's costs of managing civilian spent nuclear fuel.[101] As of August 1997, the NWF through fees collected, interest earned, and payments owed, totaled over $12 billion, of which $4.8 billion was expended on repository related activities.[102] Annually the fee generates approximately $630 million.

In exchange for paying the fee, NWPA requires utilities to enter into contracts with the Secretary for the acceptance and disposal of their spent fuel.[103] The contracts are called *Standard Contracts for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste*[104] and provide that DOE will take title to the spent nuclear fuel as quickly as practicable following the operation of a repository and in return for payment of the fees, will dispose of the spent nuclear fuel not later than January 31, 1998.[105] Because a radioactive waste repository is not expected to be operable until at least 2010, the federal government obviously has not met the January 31, 1998 deadline.

Many states and utilities are concerned about DOE's inability to meet its obligations under NWPA. On May 3, 1995, to address the concerns of nuclear reactor owners, DOE published its Final Interpretation of Nuclear Waste Acceptance Issues.[106] In the Final Interpretation, DOE stated it would not be able to accept spent nuclear fuel by January 31, 1998. DOE concluded it did not have an unconditional statutory or contractual responsibility to accept high-level waste and spent fuel starting January 31, 1998 in the absence of a repository or interim storage facility constructed under NWPA.[107] In response, several utilities and state commissions who paid fees to the NWF sought review of DOE's order. In *Indiana Mich. Power Co. v. Dep't of Energy*,[108] the District of Columbia

99 42 U.S.C. § 10222(d) (West 1995).
100 42 U.S.C. § 10222(a)(2)-(3) (West 1995).
101 42 U.S.C. § 10222(a)(4) (West 1995).
102 H.R. REP. NO. 105-290, pt. 1, at 26 (1997).
103 42 U.S.C. § 10222(a)(5)(A) (West 1995).
104 10 C.F.R. § 961.11 (1983).
105 42 U.S.C. § 10222(a)(5)(B) (West 1995).
106 60 Fed.Reg. 21, 793 (1995).
107 60 Fed.Reg. 21, 793-94 (1995).
108 Indiana, 88 F.3d 1272, 1272-1277 (D.C. Cir. 1996).

Circuit Court of Appeals held that DOE's responsibility to accept radioactive waste was not conditioned on the existence of a repository or other facility.[109] Thus, DOE had a responsibility to start disposing of the radioactive waste no later than January 31, 1998. At the time of the lawsuit, however, DOE had not yet defaulted on its statutory or contractual obligation, so the court declined to designate an appropriate remedy.[110]

Recent cases affirm that the federal government is liable to nuclear utilities for failing to receive their spent radioactive fuel by January 31, 1998.[111] As a result, utilities are engaged in suits against DOE for damages totaling $8.5 billion with total liability projected to reach as high as $40 to $80 billion.[112] This is more than the cost of building the repository and transporting the waste to Yucca Mountain, which is estimated to cost $58 billion.[113]

United States taxpayers, not the utilities, will ultimately pay for nuclear waste disposal. The damages the government owes the utilities will either come out of the NWF[114] (which is payed for by electricity consumers in the form of increased utility rates) or general revenues (which are payed for by United States taxpayers). Even if a repository was completed and ready to accept nuclear waste by January 31, 1998, the transportation of the waste and construction would still be payed for by the NWF. Essentially, the statuory framework of NWPA allows the utilities to receive all the profits of nuclear electricity, while the public receives all the financial burdens and responsibilities of disposing of their radioactive waste.

One outcome of not being able to accept nuclear waste by NWPA's deadline is that spent fuel is piling up at nuclear reactors. State law limits the amount of spent fuel stored on site at many nuclear facilities.[115] If the utilities are unable to give their waste to the federal government for disposal, they may be required to shut down prematurely.

---

109 *Id.* at 1277.

110 *Id.*

111 *See* Maine Yankee Atomic Power Co. v. U.S., 225 F.3d 1336, 1343 (Fed. Cir. 2000) (DOE's failure to begin disposal services by specified date constituted breach of contract); Northern States Power Co. v. U.S., 224 F.3d 1361, 1367 (Fed. Cl. 2000) (utilities may maintain their damage suit against DOE for breaching contractual NWPA obligation).

112 Flint, *supra* note 48, at 165.

113 Lawrence O'Rourke, *House Backs Yucca Dump*, SACRAMENTO BEE, May 9, 2002, at A18.

114 There is debate over whether paying damages qualifies as one of the designated legal uses of the NWF. The list of designated uses is located at 42 U.S.C. § 10222(d) (West 1995).

115 Flint, *supra* note 48, at 165.

Lastly, NWPA mandates that the federal government transport the nation's commercial high-level radioactive waste to a federal storage facility, by utilizing private industry to the fullest extent possible.[116]

IV. The Proposed Yucca Mountain Repository

This section discusses the location of Yucca Mountain, the underground design of the facility, the current status of the repository, and Nevada's legal battle against the site.

A. The Site

The repository at Yucca Mountain is located 100 miles north of Las Vegas, Nevada. The nearest neighbor to the site is a legal brothel located eighteen miles away.[117] The site includes part of the Nevada Test Site and the Nellis Air Force Base. The site is also part of the Western Shoshone people's traditional homelands, as recognized by the United States government when it signed the Treaty of Ruby Valley in 1863.[118] DOE spent $6 billion over fifteen years researching the Yucca Mountain repository.[119]

B. The Proposed Repository

The surface buildings of the repository will cover over 150 to 400 acres.[120] Special facilities for receiving, unloading, and handling the containers of spent fuel and high-level radioactive waste will be built along with offices, maintenance and repair shops, and warehouses. The underground facility will be even larger, encompassing approximately 1400 acres.

The repository will contain numerous tunnels drilled deep into a geologic structure, with each of the tunnels containing bore holes into which waste containers will be placed.[121] The site will encompass 150 miles of service and storage tunnels 1400 feet below Yucca Mountain. Spent fuel will be transported to the site and then reloaded into storage containers. 12,000 very large containers of spent fuel from commercial nuclear reactors along with 4500 smaller containers of high-level nuclear weapons production waste would be transported down into the tunnels.[122] Locomotives will pull the containers into the tunnels, and robots would

116 42 U.S.C. § 10157(a)(2) (West 1995).
117 Gerrard, *supra* note 25, at 1077.
118 18 Stat. 689.
119 Sypula, *supra* note 14, at 251.
120 *Id.*
121 *Id.* at 254-55.
122 Luther J. Carter & Thomas H. Pigford, *Getting Yucca Mountain Right*, 54 Bull. Atom. Scientists 56 (Mar.-Apr. 1998).

monitor the site for 100 years. "The containers, made of corrosion-resistant stainless steel and designed to shield radiation from the environment for 1000 years, would provide an extra, engineered barrier to augment the geologic barrier. After the containers are placed into individual bore holes, the holes would be sealed with a liner and closed at the surface."[123]

C. Current Status

On January 10, 2002, Spencer Abraham, the Secretary of Energy, provided Nevada Governor Kenny Guinn a thirty-day advance notice that the Yucca Mountain site would be recommended to the President as the nation's high-level nuclear waste repository.[124] Guinn responded: " I am damn disappointed in this decision and to expect my veto . . . we will fight it in Congress, in the Oval Office, in every regulatory body we can . . . I told the Secretary that I think this decision stinks, the whole process stinks and we'll see him in court."[125] Nonetheless, on February 14, 2002, Secretary Abraham recommended Yucca Mountain as the radioactive waste repository to the President. President Bush officially approved the site on February 15, 2002.[126] Guinn issued a Notice of Disapproval on April 8, 2002, within the sixty days allowed.[127] Congress had ninety days to override the veto for progress at Yucca Mountain to continue. If no vote in Congress occured, or no simple majority was attained in the House of Representatives and the Senate, the veto would stand and DOE would then have six months to come up with a new repository plan and report it to Congress.[128]

On May 8, 2002, the House of Representatives voted 306-117 to approve the creation of the nuclear waste dump at Yucca Mountain.[129] On July 9, 2002, the Senate passed S.J. Res. 34, approving the radioactive

---

123 JAMES FLYNN, ONE HUNDRED CENTURIES OF SOLITUDE 22 (1995).

124 Matthew L. Wald, *Nevada Site Urged for Nuclear Dump*, N.Y. TIMES, *at* http://www.courses.wcupa.edu/tlutz/ess102021/nuclear.doc (Jan. 11, 2002).

125 Betsy Tompkins, *Abraham Announces Intent to Recommend Site for Repository; Reactions Abound*, NUCLEAR NEWS, Feb. 2002, at 15.

126 President's Letter to the Speaker of the House and the President of the Senate Recommending Yucca Mountain, 2002 WL 228239 (Feb. 15, 2002).

127 OFFICE OF GOVERNOR KENNY GUINN, NEVADA GOVERNOR GUINN DECLARES "THE BATTLE BEGINS" AS HE VOTES YUCCA MOUNTAIN NUCLEAR DUMP RECOMMENDATION, *at* http://gov.state.nv.us/pr/2002/4-8YUC.htm (Apr. 8, 2002).

128 Suzanne Struglinski, *Yucca Mountain: As Selection Process Continues, So Does; Conflict or Science, Politics*, GREENWIRE, Apr. 2, 2002.

129 O'Rourke, *supra* note 113, at A1.

waste repository at Yucca Mountain.[130] DOE must now file a license application to NRC before it can build and operate the repository.[131]

Nevada is also fighting the Yucca Mountain site in court. The Nevada Protection Fund was established to raise funds to legally challenge the Yucca Mountain repository.[132] The City of Las Vegas contributed $100,000, Nevada gave $4 million, Clark County donated $1 million and a variety of other organizations and cities donated between $1000 and $50,000 each to stop the development of the Yucca Mountain repository.[133] The following is a list of some of the many Yucca Mountain issues Nevada challenged or is challenging:[134] DOE's citing guidelines,[135] NWPA amendments designating Yucca Mountain as the sole location for site review,[136] DOE's Environmental Impact Statement, NRC's decision to issue DOE a construction authorization for a repository, DOE's groundwater permit to construct and operate the site, and EPA's radiation protection standard.

V. WHY THE YUCCA MOUNTAIN REPOSITORY SHOULD NOT BE APPROVED AT THIS TIME

The nation's radioactive waste dump should not be located at Yucca Mountain for the following reasons: transportation risks, human health and safety risks, equity, politics, earthquakes, and volcanic activity.

A. Transportation Risks

Transporting radioactive waste from seventy-three reactor sites throughout the country to Yucca Mountain will create substantial human health and safety and environmental risks. Approximately 100,000 shipments of high-level radioactive waste will be transported through forty-

---

130 Greg Gordon, *Senate Approves Yucca Dump Site*, SACRAMENTO BEE, July 10, 2002, at A1.

131 *President Bush and Congress Approve Yucca Mountain as Repository Site*, Nuclear Energy Institute, *at* http://www.nei.org/doc.asp?catnum=2&catid=232 (last visited Sept. 30, 2002).

132 Tompkins, *supra* note 125, at 15.

133 *Id.*

134 Sypula, *supra* note 14, at 256.

135 *See* Nevada v. Watkins, 939 F.2d 710, 719 (9th Cir. 1991); (Nevada requested review of the General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories. The court dismissed Nevada's petition in holding that the guidelines were reviewable only if they constituted a final recommendation of the secretary to build a repository at Yucca Mountain. Therefore, Nevada does not have a cause of action against the secretary for citing criteria until after Yucca Mountain is designated as the radioactive waste repository).

136 *See* Nevada v. Watkins, 914 F.2d 1545, 1545-1564 (9th Cir. 1990); (The Property Clause of the Constitution grants Congress the authority to designate Nevada as the sole site for a potential nuclear waste facility. Additionally, NWPA preempts Nevada's legislative veto of the Secretary's site characterization of Yucca Mountain).

three states over a thirty-year time period to fill the repository.[137] The spent fuel will be placed in nuclear waste transportation casks. The current transportation casks weigh forty tons for road transportation and 100 tons for rail transportation.[138]

The transportation casks were never fully physically tested to transport high-level radioactive waste.[139] In 1987, NRC sponsored a study done by the Lawrence Livermore National Laboratories which used computer modeling to predict cask responses to accident conditions. The study did not incorporate real life, full-scale testing of the casks. In addition, the test criteria relied on traffic volumes, travel speeds, and hazardous cargoes on roads and railroads from the 1960s. Realizing the need for a more adequate study, NRC recently contracted with Sandia National Labs to conduct a new study, titled "Modal II" or the "Package Performance Study." This study will not be complete until 2003. Congress therefore decided the fate of the geologic repository without knowing whether transportation to Yucca Mountain is safe.

Humans and the environment located near high-level radioactive waste transportation routes may be adversely impacted. By the end of 1995, 1300 shipments of spent fuel were made.[140] Four of these shipments involved accidents but the contents of the casks were not released in any of the accidents. It is likely there will be more collisions in the future because train accidents are more common today than in the past.[141] Train accidents increased by fifteen percent between 1999 and 2001.[142] Train derailments increased thirty-two percent between 1998 and 2001. Increased rear-end collisions, faulty equipment, and train crashes with cars, made 2001 the worst railroad safety year in a decade.

In addition to the possibility of an accident, the perceived risk of escaped radiation decreases property values along major nuclear waste routes.[143] In *Texas Electric Service Co. v. Nelon*,[144] a public utility company brought a condemnation proceeding against property owners to acquire an easement as a right-of-way strip for a railroad spur through the property owners' 358-acre peanut farm. The farm was used solely for the production of peanuts, and as a weekend retreat.[145] One of the purposes

---

137 PUBLIC CITIZEN, RADIOACTIVE ROADS AND RAILS, *at* http://www.citizen.org/cmep/energy_enviro_nuclear/nuclear_waste/hi-level/transport/index.cfm (last visited May 20, 2002).

138 Fred Bosselman, *Disposal of Radioactive Waste*, A.L.I. 59, 67 (Aug. 13, 1998).

139 PUBLIC CITIZEN, *supra* note 137.

140 Bosselman, *supra* note 138, at 67.

141 Seth Borenstein, *Tracks, Maintenance Suspected in Rising Rail Crashes*, SACRAMENTO BEE, Apr. 25, 2002, at A6.

142 *Id.*

143 Texas Electric Service Co. v. Nelon, 546 S.W.2d 864, 869 (Tex. Ct. App. 1977.)

144 *Id.* at 865-870.

145 *Id.* at 865-866.

of the easement was to carry nuclear waste away from the Comanche Peak generating plant to the main Santa Fe Railroad line.[146] The Texas Court of Appeals upheld the lower court's determination of damages, allowing the property owners to receive an additional $300 per acre, above the fair market value of the land, due to a reduction in their property value based on actual fear or reasonable fear associated with the transportation of radioactive waste.[147] This fear was based in part by the land owners' expert witness who stated that the transportation of nuclear waste across their land, "present[ed] an actual danger from escaped radiation along the ten-mile right-of-way because of the danger of accidents or sabotage along the route."[148] At trial, an additional witness testified that "there was greater diminishment in the value of small tracts near a railroad than in the value of those farther away."[149]

A 1992 New Mexico Supreme Court case reaffirms the notion of reduced property values as a result of public fear associated with the transportation of radioactive waste.[150] In *Santa Fe v. Komis,* the court awarded a couple $337,815 in damages for the perceived loss of their property value due to the public fear of nuclear waste.[151] The City of Santa Fe brought a taking condemnation proceeding against John and Lemonia Koomis, to use their property for the construction of a highway to transport nuclear waste to a Waste Isolation Pilot Project site.[152] The court held that property owners could recover for decreased market value caused by public perception, regardless of whether the public's fear was reasonable.[153]

Citizens living near nuclear waste transportation routes should not foot the bill for decreased property values or for the inability to sell their home as a result of public fear of radioactive waste transport.

B. Human Health and Safety Risks

If the high-level radioactive waste at Yucca Mountain entered the air, drinking water, or food, it would be very dangerous to humans. Water is the most likely vector by which radioactive material could be released from the repository.[154] The rate of migration from the repository to the water table at Yucca Mountain is uncertain. Nevada state scientists believe the time of migration is less than 1000 years but scientists for

146 *Id.*
147 *Id.* at 868.
148 *Id.* at 868-869.
149 *Id.* at 867.
150 Santa Fe v. Komis, 114 N.M. 659, 659 (1992).
151 *Id.* at 661-662.
152 *Id.* at 661.
153 *Id.* at 662.
154 Sypula, *supra* note 14, at 259.

DOE believe the time is many thousands of years. Recent discoveries of chlorine-36 600 feet below the Nevada ground legitimize the Nevada scientists' concerns. The chlorine-36 was left over from nuclear weapons testing in the atmosphere. Precipitation infiltrated the rock and carried the chlorine-36 600 feet below the ground in less than fifty years. This substantiates the theory that Yucca Mountain's rock pores are very fractured and thus radioactive elements can travel from the repository to the water table in a shorter period of time than DOE predicted. DOE responded by saying that even with fast groundwater movement, the movement would dilute any radioactivity in the water table.[155]

If radioactive waste entered the ground water due to an earthquake, volcanic activity, natural geologic changes, or corroded waste canisters, eventually people would be harmed by drinking the contaminated water, eating produce and meat grown with the contaminated water, and drinking milk from cows that were exposed to radiation through their feed and water. The following hypothetical describes the process by which radioactive waste could reach the ground water and impact human health.[156] Based on DOE's 1998 repository performance assessment, a radioactive plume would begin to form within the first 5000 years after the repository closes.[157] The plume would be roughly in the shape of the repository above it. It would reach two and a half miles wide, two miles long, and have a depth of 160 feet. With time, it would become more elongated and move closer to the earth's surface as it followed the aquifer to the south. Traveling at a rate of thirty feet a year, after 7000 years the plume would pass beneath U.S. 95, the highway from Las Vegas to Reno. After 7500 years, the plume would reach the wells in Amargosa Valley. After 11,000 years it would reach Franklin Lake Playa or Alkali Flat where the aquifer nears the surface.[158] Amargosa Valley and Alkali Flat contain wells that are used for irrigation to water alfalfa, which is used to feed cows that deliver more than 30,000 gallons of milk daily to Los Angeles.[159]

Near Alkali Flat, the water would be drawn into the surface environment and atmosphere by the roots of plants and evaporation.[160] Some radioactivity would begin to deposit at or near the surface as solids, subject to dispersion by wind and water. The contaminated soil would blow into the air as dust particles, and people would inhale the contaminated

---

155 *Id.* at 260.

156 Carter & Pigford, *supra* note 122, at 56.

157 *Id.*

158 *Id.*

159 Sypula, *supra* note 14, at 259.

160 Carter & Pigford, *supra* note 122, at 56.

soil.[161] The plume, would remain in place for hundreds of thousands of years, with the concentration of contaminants increasing over its forty-mile length as more and more radionuclides travel downward from the repository to the aquifer below.[162]

In 10,000 years, the annual dose from drinking contaminated water from wells three miles from the repository would be approximately 0.02 rem per year.[163] When the dose from eating food contaminated by irrigation water from the wells is added, the total dose would be about 0.13 rem. This is thirteen times the annual dose limit set by NRC two decades ago for persons living near nuclear power plants.[164]

As this example shows, if radioactive waste leaks into the ground water, the health of nearby residents who depend on the aquifer as their sole source of potable water would be adversely impacted.[165] The health of Nevada, California, Utah, and Oregon residents would also be at risk[166] The aquifer under Yucca Mountain is part of the Great Basin, consisting of a large drainage system covering these four states.[167] The harms associated with ingesting and inhaling radioactive materials are discussed in the *Potential Health and Environmental Effects* section of this paper.

C. Equity

Nevada is being "singled out as a sacrificial lamb for the nuclear power industry" because the state is politically weak.[168] Nevada is required to store the entire nation's high-level radioactive waste even though it does not generate any nuclear waste.[169] Nevada citizens should not have to bear the radioactive waste burden of the entire nation. The current on-site storage solution for high-level radioactive waste is more equitable because it distributes the waste around the country in the locations where it is produced. Those who derive benefit from commercial nuclear reactors in the form of electricity also feel the environmental burden associated with the nuclear process.

The Yucca Mountain site will inequitably impact the health, safety, economy, and natural environment of Nevada citizens. The health and

---

161 Kevin Kamps, *Comments on the Department of Energy's Draft Environmental Impact Statement*, Nuclear Information and Resource Service, *at* http://www.nirs.org/dontwasteamerica//YMDEISComments.htm (Feb. 28, 2000).

162 Carter & Pigford, *supra* note 122, at 57.

163 *Id.*

164 *Id.*

165 PUBLIC CITIZEN, *supra* 137.

166 M. Bakker et al., *Regional Groundwater Modeling of the Yucca Mountain Site Using Analytic Elements*, 226 J. HYDROLOGY 167, 167 (1999).

167 *Id.*

168 SCHOENBAUM & ROSENBERG, *supra* note 11, at 795.

169 *Id.*

safety of Nevada citizens will be placed at risk. All 100,000 shipments of radioactive waste will pass through and stop in Nevada, making transportation risks much greater for Nevada residents. If radiation from the repository contaminates the air, soil, and/or water table, individuals living or working near the site will be harmed to a greater extent than people living farther away from Yucca Mountain. Following the September 11, 2001 terrorist attacks in America, we must also consider that concentrating the nation's high-level radioactive waste in one location may increase the risk of a terrorist attack in Nevada.[170] In the event of a nuclear release, harm to Nevada human health and safety would substantially increase.

Moreover, Nevada citizens are already inequitably impacted by the effects of radioactive waste and research because the nation's nuclear weapons test site is located in their state.[171] More than 900 nuclear tests were conducted at the test site, which is located on the edge of Yucca Mountain.[172] Some Nevada residents suffered diseases as a result of the open-air testing of nuclear weapons in the 1950s and early 1960s.[173] The long history of nuclear testing in Nevada presents another reason why it is inequitable to require Nevada citizens to bear the burden of the nation's nuclear waste.

In addition to adversely impacting human health and safety, a nuclear accident near Las Vegas would stigmatize the area and cause a significant number of tourists to stay away.[174] Even without a nuclear explosion at Yucca Mountain, the mere fact that the area will store nuclear waste will deter visitors. Because of the high profile nature of nuclear waste disposal, and the public fear associated with radioactive waste, a majority of Americans would be aware of and fearful of the Yucca Mountain site.[175] Research shows that individuals are more worried about catastrophic events than ordinary day-to-day risks, even if they have a less chance of occurring.[176] The nuclear industry and regulatory experts argue that the probability of a major nuclear meltdown at a large reactor ranges from "a chance of one in 100,000 to one in a billion per year."[177] Even so, nuclear accidents such as Chernobyl and Three-

---

170 Marta Adams & Andrea Nichols, *The Yucca Mountain Fight is Far From Over*, NEV. LAWYER 26 (Feb. 2002).

171 Gerrard, *supra* note 25, at 1077; Scott R. Helton, *The Legal Problems of Spent Nuclear Fuel Disposal*, 23 ENERGY L.J. 179, 184 (2002).

172 *Id.*

173 Gerrard, *supra* note 25, at 1078.

174 *Socioeconomic Issues Associated With a High-Level Radioactive Waste Repository at Yucca Mountain*, *at* http://www.state.nv.us/nucwaste/yucca/socio01.htm (last visited May 20, 2002).

175 *Id.*

176 Sypula, *supra* note 14, at 262.

177 SCHOENBAUM & ROSENBERG, *supra* note 11, at 788.

Mile Island leave prominent images in peoples' minds of the dangers associated with nuclear power.[178] Even if the government and nuclear industry persuade the public that the dangers associated with a repository are small, the severity of the danger will take precedence in most people's risk calculations. As a result, people will be extremely fearful of Yucca Mountain.

If negative nuclear waste perceptions are associated with Nevada, the state will most likely experience a decline in tourism and new industry growth.[179] For every potential casino in Nevada that would change its mind due to Yucca Mountain, the state estimates it will lose 14,200 jobs and approximately $500 million in annual revenue.[180] This is compared to the estimated 3000 to 4000 jobs created by the construction and operation of the repository. Therefore, operating a high-level radioactive waste dump at Yucca Mountain will hurt more than help Nevada's economy.

D. Politics

Politics, not science, drives the Yucca Mountain decision. A recent poll conducted by Mason-Dixon Polling and Research Inc. supports this notion.[181] Sixty-eight percent of Nevada citizens believe the repository will be constructed regardless of what scientific research shows.[182] A good example of Nevada's lack of political power is the 1987 amendment to NWPA, directing DOE to study a repository only at Yucca Mountain, Nevada.[183] It is impossible to scientifically pick the best location for a national geologic repository if you limit the research to only one site.

In 1987, when Sen. Bennett Johnston (D-La.) persuaded the Senate Appropriations Committee to add the NWPA amendments (S- 1668) to an Energy and Water Projects appropriation bill for the 1988 fiscal year (H.R. 2700), Nevada did not have powerful Senate representation.[184] In 1982, Sen. Chic Hecht (R-Nev.) was elected by defeating four-term Sen. Howard Cannon (D-Nev.).[185] Sen. Harry Reid (D-Nev.) became senator when former Sen. Paul Laxalt (R-Nev.), once a governor of the state and friend of Reagan, retired in 1987. Nevada had Hecht and a freshman senator in the Senate the year the NWPA amendments were attached to

---

178 *Id.*

179 *Socioeconomic Issues Associated With a High-Level Radioactive Waste Repository at Yucca Mountain*, *supra* note 174.

180 *Id.*

181 Tompkins, *supra* note 125, at 52.

182 *Id.*

183 42 U.S.C. § 10172 (West 1995).

184 Mark E.Rosen, *Nevada v. Watkins: Who Gets the Shaft?*, 10 VA. ENVTL. L.J. 239, 252 (Spring 1991).

185 Struglinski, *supra* note 128.

a larger bill and enacted into law. The fact that the NWPA amendments became part of a larger spending bill made it more difficult for Nevada to stop progress at Yucca Mountain because it made it impossible to measure who voted in favor of or against the site.

Nevada is consistently at a political disadvantage in the radioactive waste disposal process because it only has two representatives. When Congress passed NWPA in 1982, western lawmakers accepted the potential for a repository in their states with the promise that elected officials in the East would be asked to make the same sacrafice. Originally the NWPA envisioned two or more repositories.[186] But in 1985, eastern lawmakers successfully eliminated their states from consideration. The original nine repository sites were located in Louisiana, Mississippi, Utah, Texas, Washington, and Nevada. Louisiana has seven representatives, Mississippi has five representatives, Utah has three representatives, Texas has thirty representatives, and Washington has nine representatives.[187] From the beginning, Nevada was badly outnumbered in the House. When the Secretary of Energy recommended three sites to the President for approval for site characterization, Nevada could not compete against Texas' thirty representatives or Washington's nine representatives.[188]

With only two representatives, Nevada has no chance against representatives from thirty-five states with seventy-three nuclear waste sites who see an opportunity to ship their radioactive waste elsewhere.[189] The majority of nuclear reactors are located in eastern states.[190] To no surprise many of the biggest Yucca Mountain supporters are eastern lawmakers. For example, Speaker of the House Rep. Dennis Hastert (R-Ill.) represents a state with seven nuclear waste sites and is one of the most vocal supporters of Yucca Mountain.[191] Representatives who do not want a high-level radioactive waste dump in their backyard (or state) are the driving forces behind Yucca Mountain, not science.

E. Earthquakes

Yucca Mountain may fail to isolate radioactive high-level waste because it is seismically active.[192] The geologic repository is supposed to be

---

186 Mark Sherman, *Nevada Left in the Nuclear Hot Seat*, SACRAMENTO BEE, May 5, 2002, at A9.

187 Jeff Trandahl, *Official Alphabetical List of the House of Representatives of the United States*, Office of the Clerk, *at* http://clerk.house.gov/index.php (Apr. 15, 2002).

188 Sherman, *supra* note 186, at A9.

189 *Id.*

190 NUCLEAR WASTE TECHNICAL REVIEW BOARD, *supra* note 22.

191 Sherman, *supra* note 186, at A9.

192 Kamps, *supra* note 161.

able to withstand the impact of a magnitude six earthquake.[193] It is reasonably possible that a magnitude six or greater earthquake will happen at Yucca Mountain within the next 10,000 years, given the state of stress and the present tectonic activity in the region.[194] Nevada places third, after Alaska and California, as the most earthquake prone state in the nation.[195] In the past twenty-five years, more than 600 earthquakes with magnitudes greater than 2.5 on the Richter scale struck within fifty miles of Yucca Mountain. In June of 1992, a 5.46 earthquake at Little Skull Mountain,[196] located 9.3 miles southeast of Yucca Mountain, seriously damaged DOE's field office.[197]

An earthquake at Yucca Mountain could potentially raise the groundwater level high enough to flood the repository.[198] Evidence shows that in the past, the water table level at Yucca Mountain rose as much as 100 meters higher than its current level. A small earthquake could potentially raise the water table at Yucca Mountain 150 meters, while a severe earthquake could raise the level almost 250 meters, which would flood the repository.[199]

F. Volcanic Activity

Along with the danger of earthquakes, Yucca Mountain is subject to volcanic activity. Volcanic eruptions, twenty miles away, formed Yucca Mountain on adjacent flat land between 7.5 and 15 million years ago.[200] Molten magma erupted into the atmosphere and clouds of ash rolled southward depositing ash, some of it so hot it welded together.[201] Over time, layers and layers of volcanic ash compressed and consolidated to form Yucca Mountain.[202] The subsurface formations at Yucca Mountain consist of heterogeneous layers of anisotropic, fractured volcanic rocks.[203] Thirty-three earthquake faults criss-cross the site.[204] The most recent eruption at the site is estimated to have occurred within the past 20,000

---

193 John Bruce Davies & Charles B. Archambeau, *Geohydrological Models and Earthquake Effects at Yucca Mountain, Nevada*, 32 ENVTL. GEOLOGY 23, 32 (Jul. 1997).

194 *Id.*

195 Kamps, *supra* note 161.

196 Davies & Archambeau, *supra* note 193, at 32.

197 Kamps, *supra* note 161.

198 *Id.*

199 *Id.*

200 Helton, *supra* note 91, at 184.

201 *Id.*

202 *Id.*

203 G.S. Bodvarsson et al., *Overview of Scientific Investigations at Yucca Mountain-the Potential Repository for High-Level Nuclear Waste*, 38 J. CONTAMINANT HYDROLOGY 3, 8 (Nov. 1999).

204 Andrew Gumbel, *Bush to Dump Nuclear Waste in Earthquake Zone, at* http://www.earlham.edu/archive/opf-l/March-2002/msg00123.html (Mar. 15, 2002).

years. The possibility of a future eruption(s) is a concern because some of the high-level radioactive waste that would be stored at the site has a half-life of tens of thousands to billions of years.

A lava pocket rests beneath the repository. A line of lava cones extends westward from Yucca Mountain. The youngest cone is closest to Yucca Mountain.[205] The Western Shoshone Nation calls the site "Serpent Swimming Westward" because the crust at Yucca Mountain is expanding westward.[206]

Yucca Mountain has an abundance of crystals with gas trapped inside.[207] The crystals were formed by hot water welling up into the mountain from below. The presence of lava beneath the site could drive hot groundwater up into the repository, flooding the waste casks. The hot water could deteriorate the casks, resulting in steam or chemical explosions within the repository. For the above stated reasons, building the repository at Yucca Mountain will create unjustifiable risks.

VI. Conclusion

The Yucca Mountain repository should not be built at this time due to human health and safety risks, environmental risks, and scientific uncertainty. By limiting radioactive waste disposal research to one site, scientists were precluded from conducting a fair alternatives analysis, making it impossible to know if Yucca Mountain is the best location for a repository. Limiting the options to one site also created an incentive for a repository to be recommended prematurely. After spending many years and billions of taxpayer dollars, policymakers and researchers were more likely to continue the project at Yucca Mountain rather than to stop progress completely and start all over again.

Additionally, NWPA does not encourage a fair discussion of solutions to the nuclear waste disposal problem. Instead of promoting discussion among scientists, policymakers, industry, and the public to truly determine if Yucca Mountain is a good solution to storing radioactive waste, NWPA implicitly supports the site. Rather than analyzing whether a geologic repository should be built in the first place, the statute designates geologic disposal as the nation's solution to spent fuel and sets the date for operation and acceptance of the spent fuel at January 31, 1998.

Very few policymakers probably knew of the risks associated with permanently storing high-level radioactive waste underground when NWPA was passed. As a result, the soonest a repository would be complete is 2010, twelve years after the date required by law. Additionally,

---

205 *Id.*
206 *Id.*
207 Kamps, *supra* note 161.

the very utilities that are producing the radioactive waste are collecting damages against the government in the billions of dollars because the Secretary breached its duty under the Standard Contracts for Disposal of Spent Nuclear Fuel.

For these reasons, the Yucca Mountain repository should not be built at this time. Instead, spent fuel should remain in storage pools and dry cask storage at the reactor sites. Once the storage pools fill up, the spent fuel should be stacked in dry cask storage until a sound scientific and moral disposal solution is presented. A repository may be the answer, but only if alternative sites can be analyzed and compared in determining the final location.